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ABSTRACT

This discussion of the use of microcomputers to simulate complex situations for classroom use describes the advantages of using simulations, including their adaptability to many subject areas and content fields, their power to explain complex concepts, and their ability to provide variations for individual users. As an example, seven objectives that were important to social studies teachers before the advent of computers are identified, including strategies (new experiences, new sources of information), content (facts and concepts), skills (inquiry and social interaction), and attitude. It is pointed out that simulations can accomplish all of these objectives except the strategy of investigating new sources of information. It is suggested that teachers who wish to develop simulations for their students must select an appropriate event, which requires careful consideration of the relationships involved, the terminology to be used, the adaptability of the event for graphic or textual representation by a microcomputer, and the characteristics of the intended learners. A sample simulation program is briefly described, and an example is given of programming in BASIC which allows inputs while the program is operating and the graphics display is being generated. The BASIC commands for this routine are listed and explained. Teachers who wish to develop their own simulations are advised to consider these conditions, and the use of the BASIC programming technique is advocated as a means of developing a more varied, active simulation. Seven references are listed. (DJR)

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DEMONSTRATING COMPUTER SIMULATION DEVELOPMENT FOR INTERMEDIATE AND MIDDLE SCHOOL APPLICATIONS

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The microcomputer is a medium through which constantly changing and complex data may be managed and displayed. Therefore, one of the many strengths of the microcomputer for educational applications is its ability to assemble complex simulations for classroom use. The advantages of the microcomputer in this type of application are that it:

> "...can enlarge the classroom to encompass the entire world and all of recorded history. Some of these simulate historical periods that cannot be recreated authentically in the classroom. Other simulations present experiences not normally available to students, such as the management of a presidential election campaign or the operation of a nuclear reactor." (1)

Simulations often are constructed so as to introduce an element of chance. Random events are "... introduced to add realism to the

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interaction."(2) Unless the technology is used, the rapid and multifaceted advantage of the microcomputer in assigning randomly selected variables is unattainable without the loss of speed or precision. In addition, Thomas and McClain point out that simulations allow us to "... compress time (as in an explanation of radioactive decay) or avoid dangerous phenomena or use of expensive equipment."(3)

Another author describes simulations as "... bridging the gap between games and pure education, depending upon the material and the program-writer's sense of humor."(4) The user is usually required to understand a set of instructions, names, and relationships to successfully compete. Users must sometimes be willing to gamble on an unknown outcome. Decisions are required as to the level of difficulty, relationships, and/or numerical selections.

The action of a simulation, though, is structured within the "... controllable world ..." of the author.(5) The author must be able to reduce the complex situation to an identifiable, and limited, number of relationships and terms. These relationships and terms must be consistently applied throughout the program to assure consistency of action.

The adaptability of simulations, their power to explain complex situations, and the ability to provide variations for individual users, all point to the increased use of them in educational applications of the future. One report, from 1980, provided a recommended direction of change when it stated that the microcomputer "... usage is predicted to shift from the current drill and practice to tutorials by 1985, and ultimately to simulations."(6) Currently, it appears that the shift to tutorial and simulation software has not occurred at the rate expected

by those authors.

Simulations are adaptable to many subject areas and content fields. They are more advanced in their adaptability to a wide range of instructional uses. We must not lose sight of the broader curriculum goals in the drive to achieve computer literacy. The microcomputer should be used as a means of achieving the goals already established.

As an example, one author has identified seven objectives which were important to social studies teachers before the advent of computers:

"STRATEGY - create new experiences for students,
STRATEGY - investigate new sources of information,
CONTENT - present facts to students,
CONTENT - present concepts to students,
SKILL - inquiry for asking appropriate questions and evaluating information,
SKILL - social interaction for learning to work with others, and
ATTITUDE - empathy for living conditions and feelings of others." (7)

Simulations, according to Rawitsch, can accomplish all of the above except the strategy of investigating new sources of information. No other type of instructional use of microcomputers is so adaptable. The power of simulations to satisfy instructional uses must be explored.

Teachers who wish to develop simulations for their students are advised to consider the selection of events and the associated decisions which lend themselves to microcomputer applications. Selecting appropriate events requires careful consideration of the relationships, terminology, adaptablility for graphic or textual representation, and the student or group audience to be addressed.

Selecting Relationships

An analysis of the curriculum should be conducted to ascertain relationships between objects and their environment which can be readily identified and quantified. It is important for those relationships to be demonstrable and replicable. Not all teaching topics lend themselves well to simulations, due to extraordinary difficulties with the concept. Usually, however, we find that the effort of constructing a simulation encourages simplification of the concept for presentation to the students. This process encourages the analysis of the underlying concepts and strategies for the problem area.

Terminology Selection

It is necessary when developing simulations to agree upon the terminolgy and its meaning before the programming is begun. This will often involve the identification of those terms which are prerequisite to the study, those involving the simulation and terms which must, of necessity, be incorporated in the program. Constant meanings must be utilized to allow interchanges within the program while structural improvements are incorporated.

Adaptablility to Microcomputers

Situations and events must be describable in words and simple graphics in order to be of use as a simulation. This may exclude certain very complex or abstract events in the teaching field. Ordinarily, though, ideas which can be expressed in print or other media will adapt to the microcomputer. In fact, often the microcomputer simulation allows a more varied, complex, and precise representation of the real situation.

Learner Characteristics

The knowledge base, learning style, psychomotor capabilities, and psychological characteristics of the intended learners ought to be examined when making a computer simulation. These differences will be of importance in the style of presentation, variability built into the programs, and rewards associated with successful completion of a program simulation.

Sample Simulation Program Hints

The simplest kinds of simulations use a data entry or inputs to enter values for a number of variables. For example, HAMMURABI requires the user to enter values for cost, population and usage to permit the recalculation of the values. When the entry is concluded, the screen is cleared to print the entire set of data and statistics for the user. These kinds of simulations proceed with no direct input into the RAM during the computation. Other, more complex simulations are possible with the microcomputer.

Let us look at an example of programming in BASIC which allows inputs while the program is operating and the graphics display is being generated. These are presenter-developed simulations which have been prepared on the middle school science subjects of: SPACE SHUTTLE LAUNCH and ORBITAL RENDEZVOUS. These programs, prepared for the APPLE II+, IIe, or III, could be used to illustrate the preparation of appropriate means of identifying potential simulations and developing programs for delivery of the selected situations.

Creation of dynamic simulations requires a mechanism for entry of data into the RAM during the execution of the program. One way to effect this is to use the "I-J-K-M" keys, in the same manner as that for screen editing, to move the cursor or screen position of the graphics pixel about. This is a common approach which is used on the Apple II family of computers. On the II+ the keys must be pressed and released continually while on the IIe the repeating function allows the user to keep the key depressed for constant input. The BASIC commands which allow this are:

```
405 REM  ** CHECK KEYBOARD ROUTINE **
415 K = PEEK (-16384): IF K > 127 THEN LET K = K - 128
    : LET A$ = CHR$(K)
420 IF A$ = "M" THEN PW = PW - 2 : IF PW < 6
    THEN GOTO 595
430 IF A$ = "I" THEN PW = PW + 2
435 IF A$ = "J" THEN AG = AG - 1
440 IF A$ = "K" THEN AG = AG + 1
445 IF A$ = CHR$(13) THEN PRINT
    : PRINT CHR$(4)"RUN MENU"
450 POKE -16368, 0 : LET K = 0
 .
 . (calculate variables and plot data)
 .
500 GOTO 405
```

This routine provides an opportunity to enter data continuously throughout the execution of this portion of the program. When the "PEEK (-16384)" statement is encountered, the Apple computer checks for the value of the last key stroke. The conditional statements allow utilization of the data only for particular entries. The program modifies the graphics values and plots the necessary points. The "POKE -16368, 0" replaces the last value with the value of zero. Therefore, during each fraction of a second, as the several lines of this program are executed, the computer first checks for then destroys any entry

made by the operator. The program continues accepting data until the limits are reached or the user is successful.

In this case, the program recalculates the "power" and "angle" for a shuttle being launched. Using only the "I" and "M" keys, on the RENDEZVOUS program permits the user to see the effect of increasing or decreasing the orbital altitude of their "chase" vehicle. Since the program cycles through this portion of the program continually, clears the memory of the last key pressed, and returns soon, this routine allows the continual input of pertinent data. Of course, using machine language would speed the operation of the action but this BASIC program permits beginning users to understand the program.

Teachers who wish to develop their own simulations are advised to consider the above conditions for any program. Using this BASIC programming technique will permit a more varied, active simulation to occur. Many opportunities to develop simulations exist in every subject area.

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